MARCUS, E. *Os Pantopoda brasileiros e os demais sul-americanos.* Bol. Fac. Fil., Cien. Letr. S. Paulo **19** (Zoologia 4): 3–179, figs. 1–17. 1940.

MEINERT, F. *Pycnogonida.* Danish Ingolf Exp. **3**(1): 1–71, pls. 1–5. 1899.

NORMAN, A. M. *The Podosomata (=Pycnogonida) of the temperate Atlantic and Arctic Oceans.* Journ. Linn. Soc. London **30**: 198–238, pls. 29–30. 1908.

RODGER, A. *Preliminary account of natural history collections made of a voyage to the Gulf of St. Lawrence and Davis Straits.* Proc. Roy. Soc. Edinburgh **20**: 154–163. 1893.

SARS, G. O. *Pycnogonidea.* Norwegian North Atlantic Exp. **6** (Zoology 20): 1–163, pls. 1–15. 1891.

STEPHENSEN, K. *Pycnogonida. Godthaab Expedition* 1928. Meddel. Gronl. **79**(6): 1–46, 12 figs. 1933.

———. *Pycnogonida from Norway and adjacent waters.* Bergens Museums Arbok 1935, Naturv. rekke **7**: 2–39, 1 fig. 1935.

WILSON, E. B. *Synopsis of the pycnogonida of New England.* Trans. Conn. Acad. **5**:1–26, pls. 1–7. 1878.

———. *Report on the Pycnogonida of New England and adjacent waters.* Report U. S. Comm. Fish. **1878**: 463–506, pls. 1–7. 1880.

ICHTHYOLOGY.—*Notes on the affinity, anatomy, and development of* Elops saurus *Linnaeus.*[1]

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C. Tate Regan in "A Revision of the Fishes of the Genus Elops" (Ann. Mag. Nat. Hist. (ser. 8) 3: 37–40. 1909), among other revisions, recognized the inhabitants of this genus on the Pacific coast of America as distinct from *E. saurus* of the Atlantic coast, with which they had been considered identical. He named the Pacific coast species *E. affinis.* In the same paper, Regan recognized the form with small scales (the one with large scales being *E. lacerta* Cuvier and Valenciennes) of the west coast of Africa as also distinct from *E. saurus*, giving it the name *E. senegalensis.* Recently I have studied many specimens of *E. saurus*, including growth series, ranging from leptocephali with virtually undeveloped fins, except for the forked caudal, to large adults. The specimens were collected in many localities on the Atlantic coast of America from Cape Cod to Recife, Brazil, and the West Indian Islands. I have had for comparison several leptocephali and a moderately large series of adults from several localities on the Pacific coast of America from Guaymas, Mexico, to Payta, Peru; also three adults from Elmina, Ashantee, Africa. The validity of the species mentioned, recognized as new by Regan, originally apparently described from few specimens, has been confirmed by this study.

Elops affinis seems to differ from *E. saurus* only in the greater number of gill rakers, wherein *E. senegalensis* agrees with *E. saurus*, as shown by Table 1. However, the scales in a lateral series are fewer in *E. senegalensis* than in *E. saurus*, as indicated in Table 2. *E. senegalensis* differs from *E. saurus* and *E. affinis* also in having fewer vertebrae. Ten specimens of *E. saurus* have, respectively, 73, 74, 75, 75, 75, 77, 78, 79, 80, and 80 vertebrae in the main axis. Nine leptocephali of the same species have, respectively, 77, 78, 78, 78, 79, 80, 82, 82, and 82 myomeres (enumerations somewhat uncertain because of indistinctness of myomeres posteriorly). The only adult *E. affinis* examined has 77 vertebrae, and six leptocephali have, respectively, 76, 77, 79, 80, and 81 myomeres. The single adult *E. senegalensis* examined has 67 vertebrae. These enumerations are in agreement with those given in Dr. Regan's revision.

So far as I know, the validity of *Elops affinis* has not been questioned. On the other hand, it was accepted by Meek and Hildebrand (Publ. Field Mus. Nat. Hist., zool. ser., **15** (1): 176. 1923), who compared specimens from the opposite coasts of Panama.

The situation with respect to *Elops senegalensis* is somewhat different, as it has been synonymized with *E. saurus*, at least, by Fowler (Bull. Amer. Mus. Nat. Hist. **70** (1): 155. 1936), though accepted by Boulenger (Cat. Fresh-water Fish. Africa **4**: 152. 1916). Although only three specimens from Africa have been available to me for examination, it is evident from the many specimens from the Atlantic coast of America studied that the range in the number of scales in the lateral series in American speci-

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mens does not include the African material examined (see Table 2), nor that reported upon by Regan, who gave a range of 94 to 98 scales in the lateral series. The specimen of *E. senegalensis* examined for vertebrae by me, as already stated, has 67 segments in the main axis, which is essentially in agreement with Regan, who gave 68 or 69. This range, 67 to 69, in the number of vertebrae in the African specimens, then is fully distinct from the range in 10 American specimens, which is 73 to 80. Although no other differences were found, there can be no doubt on the basis of those set forth that the African specimens are distinct from the American ones. Therefore, *E. senegalensis* stands as a valid species.

It may be noted, incidentally, that the specimens from Payta, Peru (U.S.N.M. 88707), gives a slight extension of the known range of *Elops affinis*, which previously apparently has been recorded only from as far south as "Ecuador." The range northward, given as "California" by Meek and Hildebrand (Publ. Field Mus. Nat. Hist., zool. ser., 15: 177. 1923), apparently should have been Lower California. The northernmost locality from which I have seen specimens is Guaymas, Mexico.

The air bladder in *Elops saurus*, which has a very thin transparent wall, occupies the full length of the abdominal cavity. Ventrally it adheres to the alimentary canal and dorsally to the body wall. Contrary to *Tarpon atlanticus*, which has much cellular tissue within the air bladder (see Babcock, *The tarpon*, ed. 4: 50. 1936; and Hildebrand, Sci. Monthly 44: 246, footnote. 1937), *E. saurus* has none whatsoever. The air bladder of *E. saurus* agrees essentially with that of *Albula vulpes*, except that in the latter the wall is somewhat thicker, and within the bladder, at about midlength, are two small kidney-shaped bodies of cellular tissue.

The alimentary canal in *Elops saurus*, except for the stomach, which consists principally of a large blind sac, is a straight tube (see Fig. 1). The blind sac projects forward to the throat. Throughout its length it lies ventrally of the main canal and parallel with it. A lobe of the liver, which occupies the space between this projection and the heart, forms a "hood" over its blind end. Another lobe of the liver shields its left side, while its right and ventral sides are covered by a "comb" of caeca bound firmly together with connective tissue. In the length of the alimentary canal this species is in agreement with *Tarpon atlanticus* and *Albula vulpes*, and also as to the presence of a large blind sac. However, in the two species mentioned last, the blind sac of the stomach projects backward instead of forward. In the possession of numerous caeca *E. saurus* and *T. atlanticus* agree, and differ from *A. vulpes*, which has only about 13.

The eggs and earliest stages of the leptocephali of *Elops saurus* remain unknown. The youngest larvae, judged principally by the development of the fins, among the

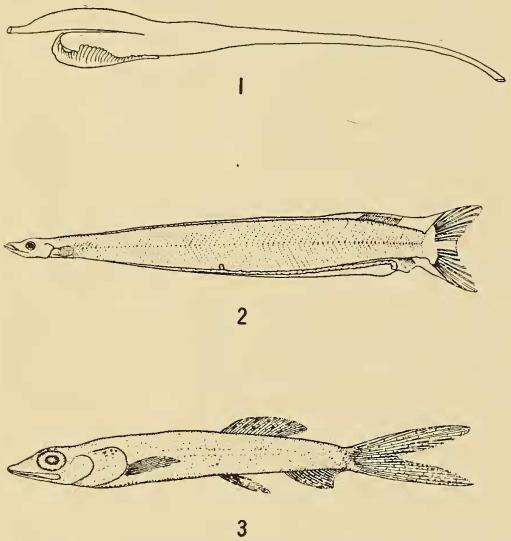
TABLE 1.—FREQUENCY DISTRIBUTION OF GILL RAKERS IN ELOPS SAURUS, E. AFFINIS, AND E. SENEGALENSIS

Species	Upper Limb							Lower limb										
	5	6	7	8	9	10	11	10	11	12	13	14	15	16	17	18	19	20
saurus	5	16	14	14	—	—	—	5	14	15	12	18	3	—	—	—	—	—
affinis	—	—	—	—	—	4	4	—	—	—	—	—	—	2	3	4	7	3
senegalensis	—	2	1	—	—	—	—	—	1	2	—	—	—	—	—	—	—	—

TABLE 2.—FREQUENCY DISTRIBUTION OF SCALES IN LATERAL SERIES IN ELOPS SAURUS, E. AFFINIS, AND E. SENEGALENSIS

Species	Oblique series counted just above lateral line																											
	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
saurus	—	—	—	—	—	—	—	—	—	—	—	1	—	2	1	2	2	1	2	1	2	1	1	1	2	—	1	—	1
affinis	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	1	—	1	3	2	—	—	1	—	1	—	—	—	—
senegalensis	1	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

many at hand are, respectively, 34, 35, and 37 mm long. Although these specimens have the forked caudal fin well developed, the other fins remain undifferentiated. These young larvae are also the most strongly compressed, that is, the thinnest and most unsubstantial ones in the collections studied. Two other larvae, although of about the same length, 34.5 and 36.5 mm long, are slightly more advanced, as a thickening within the finfolds indicates the development of the dorsal and anal fins (see Fig. 2).



Figs. 1–3.—*Elops saurus* Linnaeus: 1, Diagram of alimentary canal showing its forward-projecting blind sac with a "comb" of pyloric caeca; 2, leptocephalus, one of the earliest stages known, drawn from a specimen 35 mm long; 3, recently transformed "young adult," drawn from a specimen only 20 mm long. All drawings by Mrs. Alice C. Mullen.

The largest leptocephali seen are, respectively, 42, 42, and 44 mm long. These specimens may represent about the maximum length attained by the larvae. However, the development at any particular length is quite uneven, as already indicated, and more clearly shown subsequently. The development in these large larvae has progressed somewhat further than in those previously mentioned, as the rays in the dorsal and anal fins are somewhat differentiated, the pectoral fins appear as tufts of membrane and the development of pelvic fins is suggested by thickened places in the abdominal wall. A considerably older specimen, "reduced" in length to 27 mm, has the dorsal and anal fins sufficiently developed to permit the enumeration of the rays, and the pectorals show signs of rays, though the pelvics remain undifferentiated. While the body remains strongly compressed, it nevertheless has become more substantial. Other specimens of the same length are more retarded as the dorsal and anal rays are scarcely differentiated.

In all the leptocephalus stages known the head is strongly depressed, and the snout viewed either ventrally or dorsally, is rather sharply triangular. Pigmentation in preserved specimens consist of two series of dark spots running the full length of the abdomen, a row being situated on each side of the alimentary canal, which in this species, as in larval herring and other herring-like fishes studied, is loosely attached to the body.

The smallest young adult, that is, a specimen that has become rather robust, though still more strongly compressed than fully developed adults, with all the fins, except the pelvics, well developed, is only 16 mm long. This specimen represents the maximum shrinkage among the many young studied. The rather numerous young adults in the collections at hand show a wide range in development. For example, a specimen scarcely 20 mm long (see Fig. 3) is fully as well developed as others around 30 mm long. Then, there is a 30-mm specimen in the collection that has advanced fully as far in acquiring characters of the adult as others 35 to 40 mm long. A great difference in development of color also is evident. The 20-mm specimen, already mentioned, has some of the silvery color of the adult, with all the color markings of the leptocephalus missing, whereas some specimens around 30 mm long remain pale, and retain the two series of dark dots on the abdomen of the juveniles already described.

The small, exceptionally advanced specimens were all taken in brackish to nearly fresh water pools and ponds, near the sea, whereas the retarded specimens were taken at sea. The indication, then, is that the environment greatly affects development.

Even though development is not uniform,

it nevertheless may be stated that generally when the leptocephali have become reduced to a length of about 20 mm they are virtually young adults. At that stage the fins, exclusive of the pelvics, are well developed, considerable thickening of the body has taken place, the outline of the gular plate is visible under magnification, and usually general pigmentation is under way. Scales begin to appear at a length of about 50 mm and by that time the teeth in the jaws, which are in a single series in the leptocephali, definitely are in bands. Scalation and pigmentation are complete at a length of 60 to 65 mm, and the young then are very similar to full-grown adults.

The leptocephali of this species evidently do not grow so large as those of *Albula vulpes*, as the longest leptocephalus of *Elops saurus* in the collections studied is only 44 mm long, whereas the largest one of *A. vulpes* has a length of 70 mm, and many others of that species are only slightly shorter. Furthermore, the leptocephali of *A. vulpes* have a rather heavier body. The larvae of the two species are readily distinguishable by the shape of the head. In *E. saurus* the head is rather broad and strongly depressed, and the snout as seen from above or from below is rather sharply triangular. In *A. vulpes* the head is notably narrower, not especially depressed, and the snout is conical. The larvae may be distinguished, also, by the number of myomeres, as *E. saurus* has about 77 to 82, whereas *A. vulpes* has about 66 to 72. When the dorsal and anal fins become sufficiently developed to permit the enumeration of the rays, the species are readily separated by the number of rays, as *E. saurus* has 21 to 25 dorsal and 14 to 17 anal rays, whereas *A. vulpes* has 14 to 17 dorsal, and only 8 or 9 anal rays.

The young of *Tarpon atlanticus* remain largely unknown, only one specimen about 20 mm long (no longer extant) having been described (Hildebrand, Copeia, 1934, No. 1: 45). This specimen was in the transition stage. It was readily distinguishable from both *E. saurus* and *A. vulpes* by the fewer myomeres, of which only 52 were present, and by the short dorsal with 12 rays and the long anal with 20 rays.

The spawning season and the place where *Elops saurus* spawns remain unknown. However, ripe or nearly ripe fish have been found. One female with large roe was caught at Beaufort, N. C., on October 23, and 20 ripe or nearly ripe fish, consisting of 7 males and 13 females, were taken in February on the Canal Zone (Hildebrand, Zoologica 24: 25. 1939). These 20 fish were chosen at random from hundreds that became stranded when the Gatun Locks were dewatered in 1935. As every fish examined, selected from among the many present, contained gonads in an advanced state of development, it perhaps may be assumed that at least most of many hundreds present were gravid fish. It seems proper to conclude, therefore, that at least some spawning takes place during our winter months.

Leptocephali in the various stages of development, already described, were collected at Beaufort, North Carolina, during January, February, March, April, May, October, November, and December. Leptocephali were collected in Texas, mostly at Corpus Christi, in February, March, April, and November. Others were taken in the Florida Keys in November, and in Cuba during May. Young adults, in or just past the transition stage, were collected at Beaufort, N. C., in March, May, June, July, and August; in Aransas Pass, Tex., in June; and at Key West, Fla., in March and November. This wide spread of time over the year of the capture of the young, even in one locality, as at Beaufort, N. C., suggests either that spawning takes place during most of the year or that the development is unequal.

If the slow development of the leptocephali of the fresh-water eels may be used as a criterion, even the youngest leptocephali of *Elops saurus* described may be several months old. Also, if the life history is similar to that of the eels the youngest larvae of *Elops saurus* at hand may have been captured far from the place of their birth. It apparently may be stated with some degree of certainty that the early stages of the leptocephali do not occur in the shallower waters in the vicinity of Beaufort, N. C., where more or less advanced stages de-

scribed herein are moderately common. In that vicinity intensive collecting with several types of gear, was carried on during every month over a period of many years in the inshore waters and to a somewhat lesser extent offshore to a depth of about 12 fathoms. The suggestion that spawning probably takes place far offshore presents itself.

Although no gravid examples of *Albula vulpes* were seen, the leptocephali and young adults were taken somewhere along the Atlantic and in the West Indies between Beaufort, N. C., and Panama, virtually throughout the year (collections for October and December only being missing). Many leptocephali and young adults of this species from the Pacific coast of Panama and a few from Colombia taken during February, March, and "autumn" also have been examined. Therefore, the remarks as to spawning made in the preceding pages probably apply equally as well to this species as to *Elops saurus*.

PROCEEDINGS OF THE ACADEMY

380TH MEETING OF THE BOARD OF MANAGERS

The 380th meeting of the Board of Managers was held in the library of the Cosmos Club on January 11, 1943. President CURTIS called the meeting to order at 8:05 P.M., with 19 persons present, as follows: H. L. CURTIS, F. D. ROSSINI, H. S. RAPPLEYE, N. R. SMITH, R. J. SEEGER, J. E. GRAF, F. G. BRICKWEDDE, F. C. KRACEK, A. WETMORE, J. E. MCMURTREY, JR., W. A. DAYTON, W. RAMBERG, E. W. PRICE, L. W. PARR, C. L. GARNER, H. G. DORSEY, and by invitation G. A. COOPER, A. SEIDELL, and L. V. JUDSON.

The minutes of the 379th meeting were read and approved.

President CURTIS announced appointment of the following committee to obtain more subscriptions of the JOURNAL from Government bureaus: F. G. BRICKWEDDE (chairman), W. W. DIEHL, and F. H. H. ROBERTS, JR.

For the Committee on Membership, Chairman KRACEK presented nominations of 12 persons (11 resident and 1 nonresident).

The Committees on Awards for Scientific Achievement for 1942, ALEXANDER WETMORE, general chairman and chairman of the Committee for the Biological Sciences, H. N. EATON, chairman of the Committee for the Engineering Sciences, and L. V. JUDSON, chairman of the Committee for the Physical Sciences, presented the names of three candidates for the awards, which were approved by the Board for announcement at the annual meeting of the academy.

The Secretary reported three deaths, three resignations, and three retirements.

The Board authorized the President to appoint a Committee on the A.A.A.S. Research Grant for 1943, which will amount to $150 for the Academy.

The meeting adjourned at 9:27 P.M.

FREDERICK D. ROSSINI, *Secretary.*

Obituaries

The death on July 13, 1942, of HENRY GRANGER KNIGHT, chief of the Bureau of Agricultural Chemistry and Engineering, United States Department of Agriculture, marked the passing of one of the most notable and interesting figures among American agricultural chemists. His 16 years as director of three widely separated State experiment stations and his 15 years as chief of a Federal bureau gave him an administrative experience in agricultural chemistry that has few parallels in the history of American science.

Knight was born on July 21, 1878, at Bennington, Kans., on a prairie farm, from which his parents moved a few years later to Port Townsend on Puget Sound. He entered Washington State University at Seattle where he earned his way by various activities. After obtaining his A.B. degree at Washington in 1902, he spent one year as student and assistant in chemistry at Chicago University, and then returned to Washington as Assistant Professor of Chemistry.

In 1904 Knight accepted the double appointment of professor of chemistry and State chemist at the University of Wyoming, the duties of which he resigned in 1910 to accept the directorship of the Wyoming Agricultural Experiment Station. His administrative duties were further increased in 1911, when he was appointed dean of the Wyoming College of Agriculture. While at Wyoming Knight published